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3 The International Market Structure of the Chemical Industry

3.1 Production Sites and Resources

Industrial development in Western countries from the beginning of the industrial revolution to today shows certain geographical patterns. A general observation is that industries always have developed along transportation lines—roads, rivers, or coastal areas, and later also along railway lines. Furthermore, specific branches of industry originate where the necessary resources were available or at least could be transported without major difficulties. Water, energy, and a skilled workforce were important resources for all chemical industries and therefore chemical plants were often established near rivers; the river Rhine is an outstanding example, with Sandoz and BASF, to name just two, situated on its banks. The daily consumption of process water for their chemical reactors exceed the quantity used by a major town. The chemical industries attracted other industry branches, such as suppliers, and of course also users of their products. Similar to the situation found for coal and iron industry or automotive manufacturers, the geographical industry patterns thus formed exist still.

Of course no company is fated to remain still, once it has chosen a site. Obviously, companies or special business units move into other regions of the world by reasons of tax policy, political climate, or for a cheaper workforce. Large industrial conglomerates in chemistry, however, are very densely integrated, which means there is a characteristic production network of coupled and combined products. Coupled products occur, for example, in a chlorine–alkali electrolysis plant or an oil refinery. For physical reasons, no single product alone can be produced, only chlorine, hydrogen, and caustic soda simultaneously, or several fractions of hydrocarbons, respectively. Combined products form a product family of related chemicals, made in a single process from appropriate reaction(s) or consecutively by further physical or chemical treatment. While physical laws and technical limitations determine the products and ideal production location for the given examples, the same considerations of products and production location are determined by

sociopolitical and economic reasons in the case of a geographical conglomeration. So we find, especially in the chemical industry, geographical concentrations in only a few areas. This is accompanied by the vertically and horizontally associated surrounding industries, namely suppliers and customers. For aspects of marketing, this means, among others, a huge concentration of market power. The supply and transformation industries for further processing which become attracted to the region in turn initiate a kind of self-accelerating process in skill concentration and mutual development. This is one reason why the chemical industry can be one of a nation's core businesses. Without any doubt, some European nations can be regarded as world leaders in chemistry, while other nations have core competencies in computer science, optics, or marketing.

Water, as a fundamental resource for chemical processes, serves also as a source of electrical energy. Where hydroelectric energy is available, namely in mountainous, rainy regions, one often finds, or found, industries which produce goods requiring energy-intensive methods such as electrolysis of bauxite to aluminum. Many of these original industries have since closed down due to ecological reasons or changed their production. In any case, with insufficient water and cheap energy, chemical industry is not possible or runs into economic problems.

The second essential resource is oil and natural gas, or alternatively coal for nations like South Africa where it can be mined at low cost. Hydrocarbons and coal serve as a basis of all organic chemistry and, of course, as an energy supply. Before and during the Second World War, fundamental processes were based principally on the chemistry of acetylene (ethyne), the decomposition product of calcium carbide when treated with water. Later, and with the cheaper sources of crude oil and natural gas, ethylene (ethene) took over this key position for conversion into other products. Therefore we have today a chemical industry largely based on ethylene and only a minority based on acetylene, which is in any case produced by cracking hydrocarbons and not from carbide decomposition.

For these reasons, chemistry, as a core competence of Western industries, is strongly dependent on oil and gas resources. As most of the supply comes out of regions with low political and economic stability, these industries are vulnerable. Of note for Europe are the pipelines from Eastern Europe, the Baku region, or from Libya can be the object of attack, can pass through regions experiencing civil war, or may simply break down through lack of maintenance. The pipelines for oil and natural gas are complemented by a further system of pipelines for industrial gases like nitrogen, oxygen, and hydrogen; other gases are transported in special high-pressure tanks. Beside these official pipelines, others do exist for military purposes. The "oil crisis" of the 1970s showed the necessity of increasing oil and gas storage, and in response artificial and natural salt caverns are used in some regions as huge gas-storage tanks. Other countries, lacking such caverns, have built underground steel and concrete tanks for the same purpose.

Another fundamental resource is salt, sodium chloride, to produce chlorine, without which industrial chemistry is not possible. Both the high reactivity of chlorine, and most of its compounds, and its simple electrolytic production makes chlorine—whether environmentalists like it or not—a key element in chemistry.

The most important resource—not only for the chemical industries—is intellectual, namely well-educated research and laboratory staff. Generally, one can find a high level of education in universities and technical high schools in Europe. However, performance is work per unit time, and the time required to study chemistry is very lengthy in Europe. Unfortunately, in recent years the attraction of studying chemistry and related sciences has declined significantly in some countries. The reason for the decline is due to the antiquated organization for education and training, for which the necessary reforms have been overdue for decades and compounded further by the reluctant employment policy of many chemical companies. The continual process of reorganization in many companies has led to many scientific employees being released from service, on account of management not knowing how to make other use of their employees' abilities.

However, there are other driving forces which may lead to geographical concentration. Small- or medium-sized high-technology industries, such as in the biotechnological sector or in gene technology, are more flexible in regard to their production site. They can more easily move into other countries, if they find the political climate too repressive or better working conditions elsewhere. So, the driving force is not a production network but the political and economic environment. In addition, the accumulation of complementary skills in a specific region is very attractive to scientists and other market participants. In this way, Ireland has within a relatively short time formed a nucleus for biotechnology. However, many scientists meanwhile have left Europe and joined research teams in the United States, where they found a better economic and academic infrastructure. Today, a nation's academic system is, more than money, a decisive factor for the establishment of industries. Funding high-technology branches is necessary but not sufficient, a fact many policy makers unfortunately do not yet know. A positive example for the cooperation between industry, politics, and science is the initiative "ChemSite" in the Emscher–Lippe region of Germany, where different efforts are combined to create innovative jobs and attract investors. The initiative is backed by an already-existing infrastructure and logistic network of chemical industries.

3.2 Fundamental Characteristics of Key Branches

It can be observed that the different branches in chemistry, especially pharmacy, biotechnology, and classical industrial chemistry, follow certain trends and develop their own characteristics. Actually a general trend is a disproportionation of the industrial structure (compare Figure 3-1). On one hand there is a shift to ever larger industry conglomerates, on the other hand to small and flexible niche specialists. This happens simultaneously with the aforementioned globalization processes. National European markets are still too fragmented and insufficiently large for existing production capacities, while overcapacities cause a significant erosion in

profit margins. Consequently, there are only two ways out of this dilemma: Fusions and mergers, in order to reduce cost by economies of scale, or create higher margins, through the production of specialties. Table 3-1 gives some examples of interesting acquisitions; these are the main reasons for industrial reorganization. Sometimes, however, the motives are difficult to recognize and mere size may be the driving force.

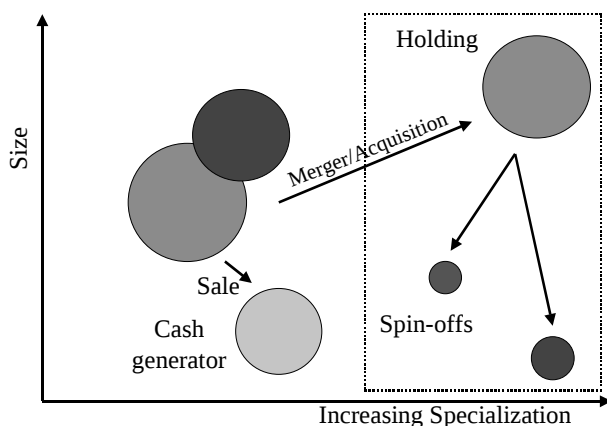


Figure 3-1 Disproportionation in industry, where the very large and very small flourish

Table 3-1 Selected acquisitions in the chemical and pharmaceutical industry

Buyer	Object	Share / Price (% / Million Euro)
The Boots Company plc	Hermal Kurt Hermann OHG	100% / 250
Degussa AG	Hüls AG	Fusion
BASF AG	Daesang	BU Lysin / 550
Fresenius AG	Pharmacia & Upjohn Co.	BU Infusion / 420
RWE-DEA AG	Hüls AG	BU Tenside, Solvent / 300
Baxter Germany GmbH	Immuno GmbH	100%
Elenac GmbH	Hostalen GmbH	100%
Kohlberg Kravis Roberts & Co.	Herberts GmbH	100% / 1500
Bayer AG	Chiron Corp.	BU Diagnostics / 950
Hoechst AG	Cargill Inc.	BU US Seeds / 550

BU = Business Unit

A really dramatic change in industrial structure has been taking place especially in the life sciences sector, namely pharmaceuticals and agrochemicals. Almost in a monthly sequence, acquisitions and mergers are announced and, consequently, the sales of business units that do not belong to either the newly defined core business or the restructured group through the formation of holdings. It seems that at the moment growth in this branch is mainly supported by acquisitions and not by intrinsic growth with new products.

3.2.1 The Agrochemical Industry

The world population is still growing at a dangerous rate. A substantial increase in food production is therefore urgently required. This can be in practice only achieved by an increase in agricultural efficiency, higher harvests per area. The increase of output through the recovery of desert land for agriculture is only possible in the long term and under stable political conditions in the countries affected. The transformation of virgin land, such as the Amazon jungle, into agriculturally usable areas is ecologically unsound. So, the efficiency can only be increased by the use of more fertilizers and/or the decrease in losses caused by plant diseases and parasites. This in turn means the application of more pesticides, fungicides, and biological methods. However, a clear shift can be observed towards smarter plant protection in order to avoid ecological damage as far as possible. Therefore a demand arises for highly efficient chemicals that rapidly and harmlessly decompose after application.

In order to avoid the application of chemicals at all, genetically modified plants have been created, which show resistances against different parasites. An example is the passionately discussed maize with an incorporated gene from *Bacillus thuringiensis*. However, it is still doubtful if this technology will be introduced on a broad scale in Western countries in the near future. Moreover, there is no need to increase food supply in these well-nourished states with their heavily subsidized agricultural overproduction.

As there is no shortage in the richer countries, the increasing demand for agrochemicals is based on the motive of convenience. However, increased ecological awareness has made farmers reluctant to use still more chemical products, and therefore the forecasted increase in agrochemical demand is not realized. The poorest nations do not have the money to buy agrochemicals, in spite of their starving population; where there is no money, there is no market. As a consequence, the concept behind life science companies may soon be revised because their agrobusinesses are not developing as fast as their pharmaceutical sector and thereby diluting the companies' profits. A further concentration of either pharmaceutical or agrochemical companies is therefore expected. Future investments in new technologies, especially in genetically modified foods, will strongly depend on the political environment and their popular acceptance. It can be assumed that most of the research in this field will occur outside Europe, most likely in the United States or even in China.

3.2.2 The Pharmaceutical Industry

In Western countries, life expectancy is increasing. However, the birth rates in industrialized countries are decreasing in direct relation with increasing wealth, in turn attributable to sociocultural change. The outcome is a disproportion in the distribution of age in the population, specifically less younger and more older people. This means that more medical care is needed—and this is growing exponentially. If money will be spent for something, then it is for personal health and welfare. Together with information technology, this is the most important global economic and marketing trend. The increase in demand for all kinds of services in healthcare will be one of the driving forces of the future economy. Unfortunately, the medical insurance systems in the Western world are not prepared for the corresponding explosion of costs.

The tremendous increase in cost for the development of a single marketable drug has meanwhile reached an average of about US\$ 500 million. Therefore it is not surprising that even big companies try to share risks and costs. In consequence, companies merge or find other ways for collaboration, such as joint development or joint marketing. The risk remains that, even after screening tens of thousands of substances for pharmaceutical efficiency and finally testing one of them in the clinical phase, this single substance may also fail in the end. It means not only the loss of hundred of millions of dollars but also loss to opportunity costs. Opportunity costs represent the money spent on an unsuccessful product is money no longer available for possibly more promising projects. Furthermore, if a substance has finally passed the admission procedures of the national authorities, its marketing is very expensive and also requires some hundreds of millions of dollars. For this reason, joint marketing in the pharmaceutical industry is common. Many big pharmaceutical companies have tried in the past to outsource their marketing activities or to reduce their own sales staff for reasons of cost. However, the forecasted savings calculated by some conservative controllers boomeranged and resulted in loss of market share. It is a different and decisive competitive advantage if a company places its focus on forming a highly skilled, academically trained sales team as discussion partners to the medical practitioners.

This particular cost structure in the pharmaceutical industry also explains why a certain selection of drugs for development is made, and in turn this means markets with a volume less than the development costs of about US\$ 500 million are not very profitable (see Figure 3-2). “Lifestyle” drugs, such as Viagra, or those against obesity are much more attractive and therefore all companies try very hard to launch a blockbuster on the market. (A blockbuster is a drug with a potential sales volume of more than US\$ 1 billion (used hereafter in the American sense of one thousand million dollars); Figure 3-3 shows some actual examples.) For the same economic reasons therefore seldom-occurring diseases do not garner the necessary attention and research for appropriate drugs is insufficiently performed. In consequence, the United States enacted the Orphan Drug Act in 1983. Seldom, by this Act, is defined as illnesses with less than 200 000 patients, and the US government decided on a package of measures, less taxes, prolonged patent rights, and so forth, in order to

promote research. Other national and international help programs try to create incentives for the research in this field. Furthermore the pressure of time in an extremely competitive situation is another criterion for the selection of a company's product portfolio.

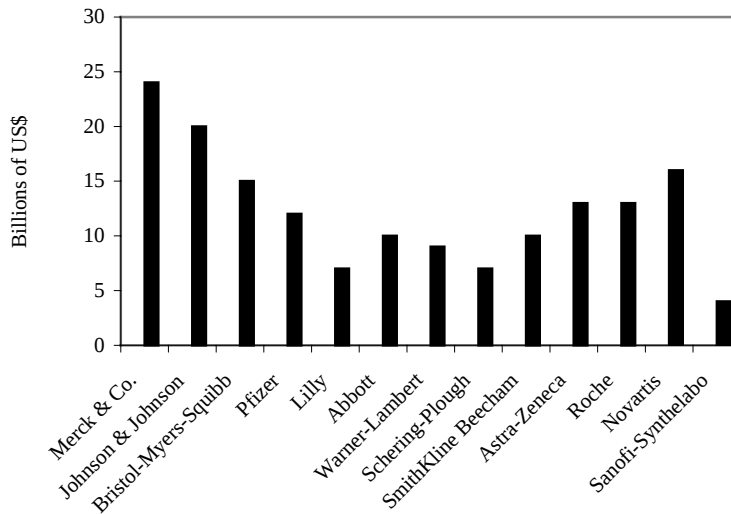


Figure 3-2 Pharmaceutical industry turnover

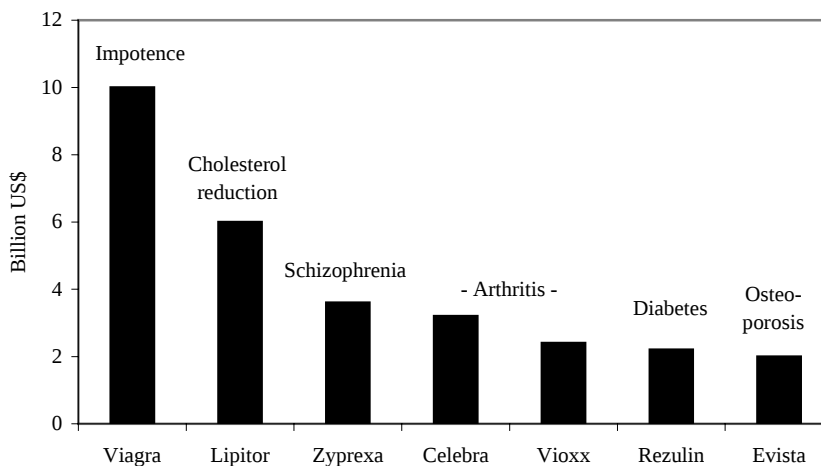


Figure 3-3 Blockbuster drugs and their applications

The pressure to create savings and to increase efficiency generates a new business branch—diagnostics, meaning companies which perform laboratory syntheses, testing, and screening of potential pharmaceuticals and other substances. The methods of combinatorial chemistry accelerates such testing of the reactivity and selectivity of chemical reactions. The reaction simulation and virtual syntheses available with computer systems show the trend. In connection with highly sophisticated analytical equipment, the diagnostics branch will show a significant increase and become a booming business. Each new diagnostic procedure, which allows a more rapid assessment of a disease and therefore earlier treatment, will help to save costs and reduce the load on our sick healthcare systems.

3.2.3 The Biotechnology and Gene Technology Industries

After the atomic and the information age, the next decades will most probably be named the biotechnological age. Biotechnology itself is a very old science. The fabrication methods of wine, beer, and cheese are based on technologies which are already some thousands of years old. Many new applications for biotechnological processes have been found meanwhile, such as for insulin, the treatment of polluted soil, or in leaching metal sulfide minerals. Biotechnology is a kind of higher chemistry with living, biologically active substances such as fungi, bacteria, viruses, cellular material, or enzymes. A lot of conventional chemical processes under high temperatures, pressure, expensive catalysts, toxic solvents, and undesirable byproducts might be converted into an ecologically gentler equivalent with milder conditions and water as solvent. Genetically modified material, like fungi or bacteria, will provide the chemical industry with new tools for syntheses. An outstanding example is the Reichstein synthesis for vitamin C (ascorbic acid), where one step in this synthetic method is reached through biotransformation in large fermentation vessels. Production capacities of several thousand tons per year have made ascorbic acid a cheap and useful additive for many food articles. Biotechnology will clearly be a very profitable business in near future and faces rapid growth. Nevertheless, biotechnology often is regarded with mistrust and even rejection in its aspect of gene technology. The different disciplines, biotechnology and gene technology, cannot be separated by a distinct border and are therefore subject to often unjustified criticism; biotechnology often uses the results of modified biological material.

3.2.4 The Commodities Industry

Dealing with the different aspects and outlooks of high technology could lead us to question whether “common” chemistry still has a future in westernized industrial

nations. When global players such as Hoechst determine life science as their future core business, and consequently try to rid themselves of their commodities, the decisions of other chemical companies are certainly influenced. The former “chemical grocer” Hoechst, under its CEO Jürgen Dorman, went through one of the most courageous metamorphoses in contemporary industry. Perhaps for this reason he was elected by a German economic review as “Manager of the Year”. However, it is quite astonishing that this policy strongly contrasts with BASF, which does just the contrary—and, so far, successfully. BASF, with its integrated production network of basic chemicals, sees the company’s market force among others just in these commodities. Covered by the title “commodities” are products designated to have an output of several hundred thousand tonnes per year. The company’s strength is defined as a vertical integration of several chemical product chains at a global scale. Product chains means, in the chemical sense, a family of connected products and, in the economic sense, a value chain. At the global scale, this means a significant market share with production centers all over the world. The global aspect of this strategy allows production capacities to be balanced with major price differences. Of course it has to be mentioned that the company also has many high-technology products. The former pharmaceuticals subsidiary Knoll AG has meanwhile been sold, however. The successful treaties with Gazprom, which allowed access to Russian sources of oil and gas, underline this policy. There are some interesting aspects in this approach, which may guarantee profitability also in future. As already mentioned in Section 3.1, the chemical industry is very dependent on oil and gas to supply both their energy and source of basic chemicals. Both categories of products are easily available on the world market—although susceptible to widely fluctuating prices. Therefore, companies which control the entire supply chain and, in addition, the transportation logistics such as pipelines have in the long term a significant cost and market advantage. This cost advantage in combination with economies of scale can lead to a most profitable leverage effect.

3.2.5 The Chemical Specialties Industry

The erosion of margins in commodities caused many companies to focus more on specialty chemicals, for example paints, pigments, ultrapure chemicals, or high-performance polymers. However, again the size of these business units and their global market share is crucial. Of course, profit margins are much higher but often market volume is rather fragmented and insufficient. Therefore in this field also acquisitions fit to the needs of the moment, either to concentrate market power by size or with complementary products.

In connection with large mergers and a reorientation of a company’s mission, business units are often sold which had created substantial profits before the merger. It is not true that only loss makers and commodity companies are subject to preferred sale. In addition the sale of chemical specialties business units contributes significantly to the finance of acquisitions. The technical experience, as well as the

market knowledge and the distribution channels, push up the sales price due to a very high degree of goodwill (Section 2.2.2). For this reason, it is sometimes difficult to find a buyer for these business units. In some cases an alternative strategy has been chosen, namely the foundation of a new and separate legal entity with its subsequent opening to the public.

In spite of the name “specialty” and smaller production volumes, this business is far from being a niche market. On the contrary, the market is highly competitive and is often confronted with the customer’s high purchasing power, thereby placing pressure on prices. The automotive industry has a significant purchasing power for varnishes, the textile industry for dyes, or the food and drug industries for vitamins. This represents an additional reason for mergers, as well as geographical diversification, in these branches as well. Customer-specific and tailor-made products are the key factors for success. Table 3-2 gives some examples of applications for specialty chemicals.

Table 3-2 Examples for applications of chemical specialties

Agriculture	Diagnostics	Paints and varnishes
Adhesives	Electronics	Plastic and rubber
Building and construction	Flavor and fragrances	Surfactants
Biocides	Food	Textile dyes
Catalysts	Industrial cleaners	
Cosmetics	Lubricants	

3.2.6 The Engineering Industry

Engineering in the chemical industry means, beside “turnkey” operations, the construction of new types of reactors. As time, before price, is a key factor of competition, batch production, with its consequent and costly downtime for cleaning and maintenance, is against the trend. Continuous reaction procedures are—whenever possible—preferred. Furthermore, flexible production facilities, multipurpose plants, are needed. Modular units facilitate both maintenance and substitution of plant components when a process has to be modernized. New engineering developments means also improved energy-saving processes. However before starting construction, clients increasingly ask for a computer simulation of the process, and only after will the definite design of the plant commence. That means an engineering company can achieve a competitive advantage in offering computer-aided simulations.

Customers often prefer a solution “from one hand”, that is a single engineering company acts as an overseer and subcontracts all of the work it cannot perform itself

to outside companies. However, the overseeing company must possess profound knowledge of construction and chemical technology as a prerequisite for survival. Additional skills in environmentally compatible techniques is often required. Understanding ecological processes is also another issue, and equipment applicable to environment protection represents a significant market. Further, while only the large companies can offer turnkey operations, this may not be restricted only to technical aspects: Training the operating staff and even financial management are often requested in the service package.

Simultaneously with the globalization of the chemical markets, the same trends are observed for chemical engineering. The construction of complete new plants in foreign countries forces the engineering companies to follow. This in turn pressures this industry branch into combining skills and strengths. More than for any other business, global mobility is a fundamental issue for engineering companies. One can expect that within a few years less than ten global players will be left.

3.3 Customers and Users

The earlier general comments in Section 2.2 on the differences between consumer marketing and B2B marketing are also true for the chemical industries. Their customers and users are limited and well known. Only in a very limited way can new markets for chemical products be created. This happens when new applications are found, such as in the automotive industry. Here, car bodies made of plastic can be used, where plastic substitutes for steel. Besides innovation, market shares can only be gained at the cost of competitors. In contrast to consumer marketing, chemicals cannot be spread among the population by stimulating consumer behavior. Only in an indirect way, when the consumption of cosmetics for example is promoted by retailers, will the producers of basic chemicals feel an effect. The derivative demand is among others a reason why chemistry is a cyclic business. When the global markets allow only limited expansion, it is obvious that the chemical demand correlates directly to the fluctuations of the general economy. Of course, consumer products are also subject—like anything else—to economic cycles, although the fluctuations are smoother. The demands for basic products and services, like food, housing, and safety, are relatively stable. In sum, that means marketing in the chemical industry is often a case of hard selling, especially when the general economy is sluggish. In such situations, the additional services offered are decisive for success or failure. Referring again to the customer's purchasing power, the credo of total customer care and strategic customer alliances gains special importance. Account management for key clients in the chemical industry therefore is a necessity. The trend in marketing goes into the direction of joint projects, where at very early stage of development customers and suppliers come together. This is a clear advantage to the bigger companies which have sufficient personnel resources.

3.4 Distribution Channels

The distribution channels for chemical products vary over a wide range. Channels are classified by the number of intermediate steps. No intermediate means direct selling from the manufacturer to the user; with intermediates a retailer lies between manufacturer and user, or a wholesaler between manufacturer and retailer. In the chemical industry all types can be found. Catalysts normally are used only by other chemical producers and therefore, in most cases, are sold directly. Products which are designed for a specific purpose are also sold directly to the client. On the other hand, there are products which will undergo several steps of transformation to a final product: Cosmetics certainly travel a longer path to the final user. The mode of transportation and special regulations have already been mentioned in Section 2.2.4.

Sometimes, however, distribution channels can be troublesome, such as when import taxes are levied on goods or even restrictions are placed on the quantity administered. In these cases a gray market often comes into existence. Global sales require a subtle pricing policy because the purchasing power between individual countries is very different and therefore the price for the same product is geographically sensitive. This is a simple relation of demand (price) and supply. However, when price differences are much higher than their transportation costs, reimports often occur. This means that the products, which are sold in other countries at a much lower price, are imported back into the countries where the company assigned a higher price. Pharmaceutical and cosmetics products often go this way.

The control of the distribution channels is a special case of a monopoly appearing in the market and is closely watched by national authorities. The owner of telecommunication lines, pipelines, or electricity suppliers will sooner or later be forced to grant competitors access to these channels. Large drug wholesalers can gain a considerable market power and influence the final price at the end of the value chain.

Finally, a few very special products are subject of strict regulations and are not freely available to everybody. Drugs, radioactive materials, biologically active substances, and the like are not sold through usual distribution channels. Some chemical substances require export licenses by the national authorities or are on an embargo list.